

**CLAIMS**

1. A monitoring unit [10] for monitoring the condition of a semi-permeable membrane [24], the monitoring unit [10] comprising a flow chamber [12] having an inlet for permitting ingress of a feed fluid into the flow chamber [12], the arrangement being such that the membrane [24] is at least partly supported in the flow chamber [12]; at least one fluid outlet [18] arranged in fluid communication with the flow chamber [12] for permitting egress of fluid from the monitoring unit [10] after having passed through the membrane [24]; and an inspection window [20] for permitting visual inspection of the semi-permeable membrane [24].
2. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] is particularly adapted for monitoring fouling of the semi-permeable membrane [24].
3. The monitoring unit [10] according to claim 1 wherein the flow chamber [12] includes a feed fluid outlet [22] for permitting at least partial through-flow of the feed fluid through the flow chamber [12] such that cross-flow conditions apply in the flow chamber [12].
4. The monitoring unit [10] according to claims 1 and 3 wherein the flow chamber [12] is dimensioned such that a fluid pressure interval is defined intermediate the feed fluid inlet [14] and the feed fluid outlet [22].

5. The monitoring unit [10] according to claim 4 wherein the fluid pressure at the feed fluid outlet [22] is less than that at the feed fluid inlet [14] such that, in use, the feed fluid partly exits through the feed fluid outlet [22] of the flow chamber [12] and in part passes through the semi-permeable membrane [24].
- 10 6. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] comprises a fluid permeable support member [16] for supporting the semi-permeable membrane [24] in the flow chamber [12].
- 15 7. The monitoring unit [10] according to claim 6 wherein the support member [16] constitutes a base portion of the flow chamber [12], the arrangement being such that feed fluid entering the flow chamber [12] passes at least in part through the support member [16].
- 20 8. The monitoring unit [10] according to claims 6 and 7 wherein the support member [16] is of any suitable porous material such as high-density polyethylene, stainless steel, brass, finely woven fiber or the like.
9. The monitoring unit [10] according to claims 6 to 8 wherein the support member [16] include pores of pore sizes between 10 and 150 µm.

10. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] includes spacer means for spacing the semi-permeable membrane [24] from the support member [16] so as to provide a flow space between the membrane [24] and the support member [16], or between adjacent membranes on the support member [16].

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11. The monitoring unit [10] according to claim 10 wherein the monitoring unit [10] accommodates different spacers that vary in thickness and shape, the arrangement being such that fluid dynamics of the feed fluid flowing across the semi-permeable membrane [24] are influenced through the use of different spacers.

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12. The monitoring unit [10] according to claim 11 wherein the monitoring unit [10] includes either a spacer that is locatable intermediate the semi-permeable membrane [24] and the support member [16] that is similar to a permeate-side spacer generally used in construction of spiral wrap elements; and/or includes a feed-side spacer similar to that used in construction of spiral elements in use, wherein the feed-side spacer is locatable on top of the semi-permeable membrane [24].

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13. The monitoring unit [10] according to claims 10 to 12 wherein adsorption kinetics of fouling substances in the feed fluid are affected by specific spacer configurations, the monitoring unit [10] thus including the potential

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for evaluating spacer technology because of its potential to include different types of spacers.

14. The monitoring unit [10] according to claims 1 and 6 wherein the fluid outlet [18] is arranged in fluid communication with the support member [16] such that fluid that has passed through the membrane [24] and the support member [16] exits the monitoring unit [10] through the fluid outlet [18].
15. The monitoring unit [10] according to claim 14 wherein the fluid outlet [18] is arranged in fluid communication with a conduit for passing the fluid through the water purification system.
16. The monitoring unit [10] according to claims 1 and 6 wherein the inspection window [20] is oriented substantially parallel to and somewhat spaced from the support member [16], the arrangement being such that the flow chamber [12] is defined intermediate the support member [16] and the inspection window [20].
17. The monitoring unit [10] according to claim 16 wherein the inspection window [20] is of any suitable transparent material, such as plastics, Perspex, glass or the like material characterized therein that it can withstand a pressure of at least between 40 and 50 bar.

18. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] includes regulating means for regulating flow across the membrane, as well as fluid pressure in the unit, the regulating means being adapted to permit repeatable or standard conditions, such as a constant cross-flow velocity and fluid pressure.
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19. The monitoring unit [10] according to claim 18 wherein the regulating means is at least one valve arranged for regulating the fluid pressure interval intermediate the feed fluid inlet [14] and the feed fluid outlet [22].
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20. The monitoring unit [10] according to claim 19 wherein the monitoring unit [10] includes at least one feed fluid inlet valve operatively associated with the feed fluid inlet [14]; and at least one feed fluid outlet valve operatively associated with the feed fluid outlet [22] of the flow chamber [12].
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21. The monitoring unit [10] according to claims 19 and 20 wherein the monitoring unit [10] includes at least one fluid outlet valve at the fluid outlet [18].
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22. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] is operatively associated with pumping means for further manipulating fluid pressure in the monitoring unit [10].

23. The monitoring unit [10] according to claim 22 wherein the monitoring unit [10] is operatively associated with a positive displacement pump arranged in-line with the monitoring unit [10] and suitable for maintaining the fluid pressure interval intermediate the feed fluid inlet [14] and feed fluid outlet [22] of the flow chamber [12].
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24. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] includes flow distribution means in the form of a manifold [28] dimensioned for preventing turbulence within the flow chamber [12] and for effecting homogenous fluid flow.
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25. The monitoring unit [10] according to claim 24 wherein the monitoring unit [10] includes an inlet manifold [28.1] arranged intermediate the feed fluid inlet [14] and the flow chamber [12] for regulating flow of feed fluid into the flow chamber [12].
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26. The monitoring unit [10] according to claim 24 wherein the monitoring unit [10] includes an outlet manifold [28.2] located intermediate the flow chamber [12] and the feed fluid outlet [22], the outlet manifold [28.2] being arranged such that it prevents areas of decreased flow in the flow chamber [12] so as to prevent preferential foulant adsorption or biological growth.
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27. The monitoring unit [10] according to claims 25 and 26 wherein the manifolds [28.1; 28.2] are arranged so as to permit reverse flow through the monitoring unit [10] for evaluating the effectiveness of back flushing on removal of impurities adsorbed onto the membrane [24].

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28. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] comprises a casing of stainless steel or the like suitable material, the casing including top cover means [30] and bottom cover means [32] that are releasably connected to each other in fluid-tight and pressure-tight engagement, the arrangement being such that the inspection window [20], flow chamber [12] and support member [16] are located substantially intermediate the top and bottom cover means.

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29. The monitoring unit [10] according to claim 28 wherein the top cover means [30] comprises a metallic frame dimensioned so as at least partially to frame the inspection window [20]; and wherein the bottom cover means [32] comprises a metallic sheet recessed at least partially to accommodate the flow chamber [12], the support member [16] and the fluid outlet.

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30. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] comprises the potential of simulating, in the monitoring unit [10], conventional fluid dynamics associated with a semi-permeable membrane [24] across the spacer means and support member [16] and is therefore

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adapted for monitoring fouling of a semi-permeable membrane [24] during operation of a water purification system.

31. The monitoring unit [10] according to claim 30 wherein the monitoring unit [10] operates at a fluid pressure corresponding to that of the water purification system, and more particularly at a fluid pressure of between 40 and 50 bar.  
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32. The monitoring unit [10] according to claim 1 wherein the monitoring unit [10] is located inline with a conventional reverse osmosis water purification system.  
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33. The monitoring unit [10] according to claim 32 wherein the monitoring unit [10] is adapted for monitoring fouling of a semi-permeable spiral membrane [24] in a spiral reverse osmosis water purification system and is located intermediate a feed fluid tank and a spiral membrane plant of the spiral reverse osmosis water purification system.  
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34. A method of monitoring fouling of a semi-permeable membrane [24] in a water purification system, the method comprising the steps of providing a monitoring unit [10] comprising a flow chamber [12] having an inlet for permitting ingress of a feed fluid into the flow chamber [12], the arrangement being such that the membrane [24] is at least partly  
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supported in the flow chamber [12]; at least one fluid outlet arranged in fluid communication with the flow chamber [12] for permitting egress of fluid from the monitoring unit [10] after having passed through the membrane; and an inspection window [20] for permitting visual inspection of the semi-permeable membrane; placing at least one semi-permeable test membrane [24] on the fluid permeable support member; effecting at least partial passage of feed fluid through the test membrane; and visually monitoring fouling of the test membrane [24] through the inspection window [20] as an indicating means for determining fouling of the semi-permeable membrane [24] in the water purification system.

35. The method according to claim 34 wherein the method comprises the step  
of effecting at least partial passage of feed fluid through the membrane  
[24] under conventional system operating conditions such that fouling of  
the semi-permeable membrane [24] is monitored during operation of the  
water purification system.

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36. The method according to claims 34 and 35 wherein the method  
particularly concerns monitoring fouling of a semi-permeable spiral  
membrane [24] in a spiral reverse osmosis water purification system.

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41. The use of a monitoring unit [10] including a semi-permeable test membrane [24] for evaluating one or more of the following operating parameters in a water purification system, namely the efficiency of different types of chemicals utilized in the system, such as anti-scalants, biocides and anti-fouling chemicals; the effect of using different membranes and/or associated spacer means in the water purification system on the operating efficiency of the system; and efficiency of different membrane cleaning methods.

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10 42. The use of a monitoring unit [10] for evaluating one or more of the following parameters in a spiral membrane reverse osmosis water purification system namely fouling of the spiral membrane; the efficiency of different types of chemicals utilized in the system, such as anti-scalants, biocides and anti-fouling chemicals; the effect of using different membranes and/or associated spacer means in the water purification system on the operating efficiency of the system; and efficiency of different membrane cleaning methods, wherein the monitoring unit [10] comprises a flow chamber [12] having an inlet for permitting ingress of a feed fluid into the flow chamber [12], the arrangement being such that the membrane [24] is at least partly supported in the flow chamber [12]; at least one fluid outlet [18] arranged in fluid communication with the flow chamber [12] for permitting egress of fluid from the monitoring unit [10].

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after having passed through the membrane; and an inspection window [20] for permitting visual inspection of the semi-permeable membrane [24].

43. A water purification system including at least one water-cleaning unit, the  
5 water purification system characterized therein that it includes a monitoring unit [10] that comprises a flow chamber [12] having an inlet [14] for permitting ingress of a feed fluid into the flow chamber [12], the arrangement being such that the membrane [24] is at least partly supported in the flow chamber [12]; at least one fluid outlet arranged in  
10 fluid communication with the flow chamber [12] for permitting egress of fluid from the monitoring unit [10] after having passed through the membrane [24]; and an inspection window [20] for permitting visual inspection of the semi-permeable membrane [24].
- 15 44. The use of a monitoring unit [10] in a water purification system wherein the monitoring unit [10] comprises a flow chamber [12] having an inlet [14] for permitting ingress of a feed fluid into the flow chamber [12], the arrangement being such that a semi-permeable membrane [24] is at least partly supported in the flow chamber [12]; at least one fluid outlet [18] arranged in fluid communication with the flow chamber [12] for permitting egress of fluid from the monitoring unit [10] after having passed through the membrane [24]; and an inspection window [20] for permitting visual inspection of the semi-permeable membrane [24].  
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